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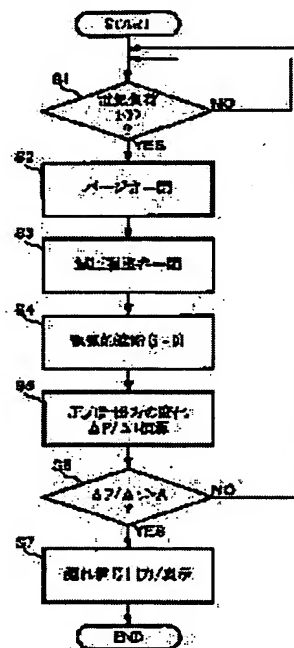
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(54) GAS LEAKAGE DETECTING METHOD AND DEVICE FOR FUEL CELL SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an inexpensive detecting device for detecting the leakage of fuel gas from a fuel gas circulating supply system during operating a vehicular fuel cell system.

SOLUTION: When a value for an output current i in a fuel cell is smaller than a threshold during regenerating decelerating energy (S1), the output current i is shut off by an output current circuit breaker to stop the generation of a fuel cell (S4) and, in turn, a purge valve for discharging water together with the fuel gas from a circulation system and a pressure reducing control valve for controlling the supply of the fuel gas from a fuel supply source are forcibly closed (S2, S3). At this point pressure in a closed space of the fuel gas circulating supply system is detected by a pressure gage, and when the detection result of the pressure gage shows pressure drop at a reference speed or faster, the leakage of the fuel gas is determined (S5-S7).



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CLAIMS

[Claim(s)]

[Claim 1] The gas leakage detection approach of the fuel cell system characterized by detecting the fuel gas leakage in said closed space based on the pressure condition in the closed space of the fuel gas circulation supply system which intercepts the output current of said fuel cell and contains said fuel cell at this time when the electric load of a fuel cell is smaller than a threshold.

[Claim 2] The gas leakage detection approach of the fuel cell system according to claim 1 characterized by intercepting compulsorily the supply of the fuel gas from a fuel source to said closed space, and detecting fuel gas leakage based on the pressure drawdown rate in this closed space.

[Claim 3] The gas leakage detection approach of the fuel cell system according to claim 1 characterized by detecting fuel gas leakage based on the pressure loss section order differential pressure in said closed space.

[Claim 4] In the fuel cell system constituted including a fuel cell, a fuel source, and a fuel gas circulation supply system An output current cutoff means to intercept the output current of said fuel cell, and a pressure condition detection means to detect the pressure condition in the closed space of the fuel gas circulation supply system containing said fuel cell, When the electric load of a fuel cell was smaller than the threshold and it is distinguished with an electric load distinction means by which the electric load of said fuel cell distinguishes a condition smaller than a threshold, and this electric load distinction means When cutoff of the output current is performed by the cutoff control means which intercepts the output current of a fuel cell with said output current cutoff means, and this cutoff control means Gas leakage detection equipment of the fuel cell system characterized by being constituted including a fuel gas leakage decision means to judge the existence of fuel gas leakage from said closed space, based on the pressure condition detected with said pressure condition detection means.

[Claim 5] In the fuel cell system constituted including a fuel cell, a fuel source, and a fuel gas circulation supply system An output current cutoff means to intercept the output current of said fuel cell, and a source-of-supply cutoff means to intercept compulsorily supply of the fuel gas from the fuel source to said fuel gas circulation supply system, A pressure detection means to detect the pressure in the closed space of the fuel gas circulation supply system containing said fuel cell, When the electric load of a fuel cell was smaller than the threshold and it is distinguished with an electric load distinction means by which the electric load of said fuel cell distinguishes a condition smaller than a threshold, and this electric load distinction means While intercepting the output current of a fuel cell with said output current cutoff means When cutoff of the output current and supply of the fuel gas from said fuel source are compulsorily intercepted by the cutoff control means which makes supply of the fuel gas from a fuel source intercept compulsorily with said source-of-supply cutoff means, and this cutoff control means Gas leakage detection equipment of the fuel cell system characterized by being constituted including a fuel gas leakage decision means to judge the existence of fuel gas leakage from said closed space, based on the fall velocity of the pressure detected with said pressure detection means.

[Claim 6] The gas-leakage detection equipment of the fuel cell system according to claim 5 by which it constitutes so that said pressure detection means may detect the pressure of each of two or more of said

closed space, and said fuel-gas leakage decision means is characterized by to judge the existence of fuel-gas leakage, and the generating part of fuel-gas leakage based on the pressure drawdown rate for two or more of said closed space of every while having a closed-space division means intercept the closed space of the fuel-gas circulation supply system containing said fuel cell to two or more closed space.

[Claim 7] Gas leakage detection equipment of the fuel cell system according to claim 5 by which said pressure detection means detects the pressure between the pressure loss sections in said closed space to each by two or more places, and said fuel gas leakage decision means is characterized by judging the existence of fuel gas leakage, and the generating part of fuel gas leakage based on the pressure drawdown rate which can be set at least to each detecting element.

[Claim 8] Gas leakage detection equipment of the fuel cell system according to claim 7 characterized by judging generating of the fuel gas leakage by about the detecting element which showed the biggest fall velocity when the biggest pressure drawdown rate of the pressure drawdown rates which said fuel gas leakage decision means can set at least to said each detecting element is larger than a threshold.

[Claim 9] In the fuel cell system constituted including a fuel cell, a fuel source, and a fuel gas circulation supply system A differential pressure detection means to detect the at least one pressure loss section order differential pressure in the closed space of an output current cutoff means to intercept the output current of said fuel cell, and the fuel gas circulation supply system containing said fuel cell, When the electric load of a fuel cell was smaller than the threshold and it is distinguished with an electric load distinction means by which the electric load of said fuel cell distinguishes a condition smaller than a threshold, and this electric load distinction means When cutoff of the output current is performed by the cutoff control means which intercepts the output current of a fuel cell with said output current cutoff means, and this cutoff control means Gas leakage detection equipment of the fuel cell system characterized by being constituted including a fuel gas leakage decision means to judge the existence of fuel gas leakage from said closed space, based on the differential pressure detected with said differential pressure detection means.

[Claim 10] Gas-leakage detection equipment of the fuel cell system according to claim 9 characterized by to judge the generating part of fuel-gas leakage based on the direction of the differential pressure in each adjoining detecting element while said differential pressure detection means detects to each two or more pressure loss sections order differential pressure which can be set in said closed space, and it judges generating of fuel gas leakage, when said order differential pressure of said fuel gas leakage decision means is larger than a threshold.

[Claim 11] The gas-leakage detection equipment of the fuel cell system of any one publication of claim 4-10 characterized by to establish a purge cutoff means intercept the purge by said purge means compulsorily, and make said closed space form when said fuel cell system is constituted including a purge means control the purge from the circulatory system of a fuel-gas circulation supply system and the fuel-gas leakage by said fuel-gas leakage decision means is made to judge.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the approach and equipment which detect the leakage of fuel gas inside a fuel cell system in detail about the gas leakage detection approach and equipment of a fuel cell system.

[0002]

[Description of the Prior Art] Conventionally, in a fuel cell system, there was an approach indicated by JP,11-224681,A and JP,8-329965,A as an approach of detecting the leakage of hydrogen content fuel gas. The approach indicated by said JP,11-224681,A judges leakage of fuel gas by computing the amount of the fuel gas used in a fuel cell, computing the fuel gas pressure in a fuel chemical cylinder from this amount of the fuel gas used based on the output current value of a fuel cell, and comparing this calculation pressure with the pressure value actually detected by the pressure sensor.

[0003] Moreover, the approach indicated by JP,8-329965,A prepares a valve in the upper section and the downstream of a fuel cell respectively, encloses fuel gas by closing said valve before a generating mode, detects the pressure variation with a pressure detection means, and he is trying to detect leakage of fuel gas based on the fall of charged pressure.

[0004]

[Problem(s) to be Solved by the Invention] However, by the approach indicated by JP,11-224681,A, there was a problem that consumption of the fuel gas by purge control might be incorrect-detected as leakage. If it becomes so that the steam contained in the humidification hydrogen content fuel gas supplied to a fuel cell serves as water around a fuel electrode and water is [system / fuel cell] full of a discharge path, the flooding phenomenon of resulting in the loss of power of a fuel cell will arise.

[0005] When fullness of water is judged as a cure of the above-mentioned flooding phenomenon based on the loss of power of a fuel cell, he is trying to make water purge using fuel gas. Here, since the fuel gas used for the purge hardly contributes to the output of a fuel cell, when the fuel gas used for the purge will be computed as a part for leakage and you are going to make it detect leakage with high precision, the problem that generating of leakage is incorrect-detected at the time of purge activation will arise.

[0006] Moreover, although the approach indicated by JP,8-329965,A is the cheap detection approach since it can judge the existence of fuel gas leakage under supervising the value of a pressure gage, since it was an approach of detecting leakage before starting, leakage generating after a start up had the fault of not being detected until it starts again. There is much possibility that leakage, such as carrying out heat deformation greatly in response to the fact that a mechanical vibration and the mechanical input of an impact which are produced with transit, and a still more nearly thermal change, will arise in the fuel cell system for cars especially during transit overwhelmingly.

[0007] Therefore, by the leakage detection approach that it is detectable that it is only before starting like the conventional example, the problem that required detectability ability is not securable to the fuel cell system for cars will arise. This invention is made in view of the above-mentioned trouble, the leakage of fuel gas can be detected also in operation, and it is in ** offering the cheap gas leakage

detection approach and the equipment of a fuel cell system.

[0008]

[Means for Solving the Problem] Therefore, with the detection approach and equipment concerning invention of claim 1 and four publications, when the electric load of a fuel cell was smaller than a threshold, the output current of a fuel cell was intercepted, and based on the pressure condition in the closed space of the fuel gas circulation supply system containing the fuel cell at this time, it considered as the configuration which detects the fuel gas leakage in said closed space.

[0009] According to the above-mentioned configuration, the electric load of a fuel cell is smaller than a threshold, and if it will be in the condition that a generation of electrical energy of a fuel cell can be stopped, a generation of electrical energy of a fuel cell will be stopped by intercepting the output current of a fuel cell. If a generation of electrical energy is stopped, it will be in the condition that fuel gas is not consumed with a fuel cell, and since the pressure condition in the closed space of the fuel gas circulation supply system containing a fuel cell comes to be influenced by only leakage, it will detect the existence of fuel gas leakage from a pressure condition.

[0010] With the detection approach and equipment concerning invention of claim 2 and five publications, when the electric load of a fuel cell was smaller than a threshold, while intercepting the output current of a fuel cell, the supply of the fuel gas from a fuel source to said closed space was intercepted compulsorily, and it considered as the configuration which detects fuel gas leakage based on the pressure drawdown rate in a closed space at this time. In the closed space where supply of the fuel gas from a fuel source is intercepted according to the above-mentioned configuration, if fuel gas flows out outside by leakage, since the pressure in a closed space will decline rapidly compared with the time of there being no leakage, generating of leakage will be detected based on whether a pressure drawdown rate is large to extent which shows generating of leakage.

[0011] With the detection approach and equipment concerning invention of claim 3 and nine publications, the pressure loss section order differential pressure in said closed space was detected, and it considered as the configuration which detects fuel gas leakage based on order [this] differential pressure. since according to the above-mentioned configuration the flow of fuel gas will occur in a closed space and differential pressure will arise before and after the pressure loss section by this flow, when the leakage from a closed space occurs -- pressure loss section order differential pressure -- being based -- the generating flow of fuel gas -- detecting -- with -- **** -- the existence of fuel gas leakage is detected.

[0012] In the configuration which detects fuel gas leakage with the detection equipment concerning invention according to claim 6 based on the pressure drawdown rate in said closed space When making leakage detect by cutoff of the output current, the closed space of the fuel gas circulation supply system containing a fuel cell is intercepted to two or more closed space. And it constituted so that the pressure of each of two or more of these closed space might be detected, and based on the pressure drawdown rate for said two or more closed space of every, it considered as the configuration which judges the existence of fuel gas leakage, and the generating part of fuel gas leakage.

[0013] According to the above-mentioned configuration, the closed space where supply of the fuel gas from a fuel source is intercepted is intercepted to plurality, and the generating part of fuel gas leakage is pinpointed in either of said two or more closed space by making a pressure detect for these two or more closed space of every. With the detection equipment concerning invention according to claim 7, it set in the configuration which detects fuel gas leakage based on the pressure drawdown rate in said closed space, the pressure between the pressure loss sections in said closed space was detected to each by two or more places, and it considered as the configuration which judges the existence of fuel gas leakage, and the generating part of fuel gas leakage based on the pressure drawdown rate which can be set at least to each detecting element.

[0014] According to the above-mentioned configuration, the multi-statement of the false closed space bordering on the pressure loss section is carried out, and the generating part of fuel gas leakage is pinpointed in either of said false closed space from the pressure drawdown rate for this every false closed space. With the detection equipment concerning invention according to claim 8, in the

configuration of claim 7, when the biggest pressure drawdown rate of the pressure drawdown rates which can be set at least to each detecting element was larger than a threshold, it considered as the configuration which judges generating of the fuel gas leakage by about the detecting element which showed the biggest fall velocity.

[0015] According to the above-mentioned configuration, although the fuel gas leakage by one place will affect other detection pressure force through the pressure loss section, since the pressure drawdown in the generating part of fuel gas leakage becomes the largest, at least the detecting element which showed the biggest fall velocity is specified as a generating part of fuel gas leakage. In the configuration which detects fuel gas leakage with the detection equipment concerning invention according to claim 10 based on the pressure loss section order differential pressure in said closed space When said order differential pressure was larger than a threshold, while two or more pressure loss sections order differential pressure in said closed space was detected to each, and judging generating of fuel gas leakage, it considered as the configuration which judges the generating part of fuel gas leakage based on the direction of the differential pressure in each adjoining detecting element.

[0016] According to the above-mentioned configuration, from the direction of pressure loss section order differential pressure, the flow direction of fuel gas can be pinpointed and the generating part of fuel gas leakage is pinpointed based on this. With the detection equipment concerning invention according to claim 11, when making the existence of fuel gas leakage judge, it considered as the configuration in which intercept compulsorily the purge from the circulatory system by the purge means, and said closed space is made to form.

[0017] According to the above-mentioned configuration, a purge is compulsorily intercepted so that leakage detection can be made to perform a fuel gas circulation supply system as a closed space.

[0018]

[Effect of the Invention] According to invention of claim 1 and four publications, when the electric load of a fuel cell is smaller than a threshold, the output current of a fuel cell is intercepted. Since the closed space where fuel gas is not consumed is made to form, for example in a vehicle use fuel cell system When regeneration of moderation energy is performed, the output current of a fuel cell is small, or when there is no need for the output current, it is effective in the ability to make fuel leakage detect and detect fuel gas leakage with a comparatively cheap pressure gage in the middle of operation.

[0019] According to invention of claim 2 and five publications, since leakage is made to detect based on the pressure drawdown in the closed space where supply of the fuel gas from a fuel source is intercepted, there is effectiveness that fuel gas leakage is detectable in the middle of operation with a simple configuration. ** is also effective in generating of fuel gas leakage being detectable with high precision, without being influenced by the absolute pressure in a closed space since the flow of the fuel gas produced by fuel gas leakage is made to detect based on the pressure loss section order differential pressure in a closed space according to invention of claim 3 and nine publications.

[0020] According to invention according to claim 6, based on the pressure drawdown for every closed space intercepted by plurality, it is effective in the ability to pinpoint the generating part of fuel gas leakage with a sufficient precision. According to invention according to claim 7, without classifying a fuel gas circulation supply system into plurality using a valve etc., the generating part of fuel gas leakage can be pinpointed and there is effectiveness of the ability to make a leakage part pinpoint with a simple configuration.

[0021] According to invention according to claim 8, even if the effect of fuel gas leakage affects at least other pressure detecting elements through the pressure loss section, it is effective in the ability to pinpoint the generating part of fuel gas leakage with a sufficient precision from a pressure drawdown rate. According to invention according to claim 10, it is effective in the ability to pinpoint the flow direction of the fuel gas accompanying fuel gas leakage, and pinpoint the generating part of fuel gas leakage with a sufficient precision from pressure loss section order differential pressure.

[0022] According to invention according to claim 11, a closed space required for detection of fuel gas leakage is made to form certainly, and when the electric load of a fuel cell is smaller than a threshold, there is effectiveness of the ability to make detection of fuel gas leakage ensure.

[0023]

[Embodiment of the Invention] The gestalt of operation of this invention is explained based on drawing below. Drawing 1 is drawing showing the vehicle use fuel cell system in the 1st operation gestalt. In this drawing 1 the fuel gas from the source 1 (fuel source) of hydrogen gas supply The fuel gas supply line 2, the reduced pressure regulator valve 3, the fuel gas supply line 4, an ejector 5, and the fuel gas supply line 6 are minded. The fuel gas which was introduced into the fuel electrode (illustration abbreviation) of a fuel cell 10, and was not consumed with a fuel cell 10 flows back to the fuel gas supply line 6 with said ejector 5 through fuel gas discharge Rhine 11 and the fuel gas circulation line 12.

[0024] A fuel gas circulation supply system is constituted by the above-mentioned fuel gas supply line 2, the reduced pressure regulator valve 3 (source-of-supply cutoff means), the fuel gas supply line 4, an ejector 5, the fuel gas supply line 6, fuel gas discharge Rhine 11, and the fuel gas circulation line 12. The purge line 14 where a purge valve 13 is infixed is connected to said fuel gas discharge Rhine 11.

[0025] A purge means is constituted by the above-mentioned purge valve 13 and the purge line 14. When making water collected on fuel gas discharge Rhine 11 discharge with fuel gas, open control of said purge valve 13 is carried out. On the other hand, to the air pole (illustration abbreviation) of a fuel cell 10, the oxidation gas (air) from the source 20 of oxidation gas supply is supplied through gas supply Rhine 21, and the oxidation gas which was not consumed with a fuel cell 10 is discharged through discharge Rhine 22.

[0026] Moreover, the ammeter 31 which detects the output current i , and the output current breaker 30 (output current cutoff means) which intercepts said output current i are infixed in the output wiring 32 which outputs the output current i of said fuel cell 10. Furthermore, the pressure gage 7 (a pressure condition detection means, pressure detection means) which detects the pressure in said fuel gas supply line 6 is formed.

[0027] The signal processor 40 into which the detection output of said ammeter 31 and a manometer 7 is inputted has the function to make the reduced pressure regulator valve 3 intercept compulsorily while controlling the switching action of said purge valve 13 and the output current breaker 30. In the above-mentioned configuration, the fuel gas flow Q_0 is supplied from the source 1 of hydrogen gas supply, and the flow $Q_1 (=Q_0+Q_2)$ which added the reflux quantity of gas flow Q_2 with the ejector 5 is led to the fuel electrode of a fuel cell 10.

[0028] In a fuel cell 10, the flow rate of ΔQ corresponding to the output current i is consumed, the fuel gas Q_2 which remained circulates, and it flows back to the fuel gas supply line 6. That is, the fuel gas flow rate supplied to the fuel electrode of a fuel cell 10 has the relation of $\Delta Q = Q_1 - Q_2 = Q_0$, and said reduced pressure regulator valve 3 supplies the fuel gas corresponding to the consumption fuel quantity (pressure drop of a fuel gas circulation supply line) in a fuel cell 10.

[0029] The electric load i demanded by the car, i.e., the output current, here In having regenerative-braking equipment which is the value which may be changed very sharply, for example, transforms car inertia energy into electrical energy at the time of car braking (at the time of moderation) Since electrical energy may be supplied by regenerative braking, the output current i from a fuel cell 10 becomes needlessness or a very small value, and at this time, the reduced pressure regulator valve 3 will intercept the flow of fuel gas, or will extract the amount of supply Q_0 minutely.

[0030] And since the conditions which make the output current zero (or minute value) will be canceled if regenerative braking is completed, the fuel gas consumption flow rate corresponding to the demand current i corresponding to car electric load is reproduced, and the fuel supply flow rate Q_0 also comes to flow out. Thus, in the fuel cell system for cars, a generation of electrical energy of a fuel cell 10 is not always required, and while the condition that a generation of electrical energy of a fuel cell 10 can be stopped operates, it generates.

[0031] In the condition that a generation of electrical energy of a fuel cell 10 is suspended, since fuel gas is not consumed with a fuel cell 10, if it is in the condition which the purge valve 13 has closed and forms a closed space, fuel gas will be shut up in a closed space and big pressure variation will not be generated. Here, when supply of the fuel gas from the source 1 of hydrogen gas supply was intercepted and the leakage of the fuel gas from a closed space occurs, the pressure of said closed space will descend

and generating of fuel gas leakage can be presumed based on the starting pressure drawdown.

[0032] Then, said signal processor 40 detects the existence of fuel gas leakage with a procedure as shown in the flow chart of drawing 2. In addition, said signal processor 40 is equipped with the function as an electric load distinction means, a cutoff control means, a fuel gas leakage decision means, and a purge cutoff means as shown in the flow chart of drawing 2.

[0033] First, at step S1, it distinguishes whether the output current i (electric load) is smaller than a threshold i_0 . And when smaller than a threshold i_0 , the output current i (electric load) progresses to step S2, and holds a purge valve 13 to a closed state compulsorily, and it is made to make the reduced pressure regulator valve 3 hold to a closed state compulsorily at the following step S3.

[0034] In addition, it is good also as a configuration which a latching valve is prepared [configuration] in the upstream or the downstream of the reduced pressure regulator valve 3, and makes supply of the fuel gas from the source 1 of hydrogen gas supply intercept compulsorily. Furthermore, in step S4, with said output current breaker 30, the output of the output current i is intercepted and a generation of electrical energy (consumption of fuel gas) of a fuel cell 10 is stopped. While the closed space which contains the fuel cell 10 with which supply of the fuel gas from the source 1 of hydrogen gas supply is intercepted by the above-mentioned processing is formed mechanically, when consumption of the fuel gas in a fuel cell 10 is set to 0 and there is no leakage of the fuel gas from said closed space, change with the big pressure detected with said pressure gage 7 is not shown.

[0035] At step S5, variation $\Delta P / \Delta t$ of per unit time amount ΔP of the detection pressure force P by said pressure gage 7 which shows the pressure drawdown rate in said closed space is calculated. In addition, said variation $\Delta P / \Delta t$ shall be computed by the value of plus to reduction change of a pressure P . And at step S6, it distinguishes whether said variation $\Delta P / \Delta t$ is larger than a threshold A .

[0036] When said variation $\Delta P / \Delta t$ is judged that the threshold A was exceeded and the reduction rate of a pressure P is over a reference value, by the leakage of the fuel gas from a closed space, it is judged as what is carrying out pressure drawdown the rate more than predetermined, it progresses to step S7, and the output and leak-detection display output of a leak-detection signal are performed. Said leak-detection display output is a control signal which performs lighting of the alarm lamp prepared near the driver's seat of a car etc.

[0037] At the fuel gas leak detection by the above-mentioned operation gestalt, since the comparatively cheap pressure gage 7 is used while generating of fuel gas leakage is detectable with a sufficient response, since the existence of fuel gas leakage can be made to judge whenever the output current i (electric load) becomes smaller than a threshold i_0 during operation (every [for example,] moderation operation), leak-detection equipment can consist of low cost. By the way, with the above-mentioned operation gestalt, since it is the configuration of forming one pressure gage 7 to the closed space of the fuel gas circulation supply system which comes to contain the reduced pressure regulator valve 3, the fuel gas supply line 4, an ejector 5, the fuel gas supply line 6, a fuel cell 10, fuel gas discharge Rhine 11, and the fuel gas circulation line 12, although it is detectable that fuel gas leakage has occurred in either of the closed space, a leakage generating part cannot be limited.

[0038] Then, as shown in the 2nd operation gestalt shown in drawing 3, while forming the latching valves 8 and 15 (closed-space division means) which carry out division cutoff of the closed space of a fuel gas circulation supply system in two more closed space As pressure gages 7 and 9 are formed for every closed space intercepted by these latching valves 8 and 15, which pressure detection value can pinpoint the part of fuel gas leakage in either of said two closed space by whether the pressure drawdown rate more than predetermined is shown.

[0039] While infixing the 1st latching valve 8 in the middle of the fuel gas supply line 6 and specifically infixing the 2nd latching valve 15 in the middle of fuel gas discharge Rhine 11, a pressure gage 7 is formed so that the pressure in the fuel gas supply line 6 between the 1st latching valve 8 and an ejector 5 may be detected, and the pressure gage 9 is provided so that the pressure in fuel gas discharge Rhine 11 between the 2nd latching valve 15 and a fuel cell 10 may be detected.

[0040] And with the 2nd operation gestalt, as it is shown in the flow chart of drawing 4, a leak detection

is performed. In the flow chart of drawing 4, like said step S1 - step S3, on condition that the output current i of a fuel cell 10 is smaller than a threshold i_0 , at step S11 - step S13, processing which holds compulsorily a purge valve 13 and the reduced pressure regulator valve 3 to a closed state is performed. [0041] Furthermore, division cutoff of the closed space of a fuel gas circulation supply system is carried out two by closing said latching valves 8 and 15 at the following step S14. And at step S15, with said output current breaker 30, the output of the output current i is intercepted and a generation of electrical energy (consumption of fuel gas) of a fuel cell 10 is stopped. Two closed space which does not show the fall with a pressure rapid when there is no leakage of fuel gas by the above-mentioned processing is formed.

[0042] In step S16, based on the detection pressure force P_1 of a pressure gage 7, Variation $\Delta P_1 / \Delta t$ (pressure drop rate) is calculated, and Variation $\Delta P_2 / \Delta t$ (pressure drop rate) is calculated at step S17 based on the detection pressure force P_2 of a pressure gage 9. step S18 -- step S -- it distinguishes whether variation $\Delta P / \Delta t$ which chose the larger one of the variation ΔP_1 computed by 16 and $\Delta P_2 / \Delta t$ [Δt and]/the Δt (the one where fall velocity is quicker), and was chosen at step S18 in step S19 is larger than a threshold A .

[0043] And when larger than a threshold A , while variation $\Delta P / \Delta t$ progresses to step S20 and performs the output and leak-detection display output of a leak-detection signal, a fuel gas leakage generating part is made to memorize by memorizing the pressure gages 7 and 9 which progressed to step S21, for example, detected leakage generating. Even if leakage occurs temporarily, the leakage section is closed after that and an alarm is no longer outputted by memorizing a leakage generating part, the hysteresis and the leakage generating part of leakage can be known later.

[0044] In addition, storage of a leakage generating part may use the memory in said signal processor 40 etc., and may be stored in the storage formed according to the individual. With this operation gestalt, since division cutoff of the closed space was carried out by latching valves 8 and 15 two for example, when the value to which the fall velocity of the detection pressure force of a pressure gage 7 is larger than another side, and exceeds a threshold A is shown Fuel gas leakage will have occurred in either of the closed space from a latching valve 15 to a latching valve 8 via the fuel gas circulation line 12 and an ejector 5. On the contrary, when the value to which the fall velocity of the detection pressure force of a pressure gage 9 is larger than another side, and exceeds a threshold A is shown, fuel gas leakage will have occurred in either of the closed space from a latching valve 8 to a latching valve 15 via a fuel cell 10 and fuel gas discharge Rhine 11.

[0045] In addition, although considered as the configuration which can pinpoint a leakage generating part in either of two closed space by carrying out division cutoff of the closed space two, and forming a pressure gage in each with the above-mentioned operation gestalt, if the number of the closed space which carries out division cutoff is set or more to three and each is equipped with a pressure gage, a fuel gas leakage part can be pinpointed more finely. However, what is necessary is for a scale, piping structure, etc. of a fuel gas distribution system just to determine a required number practically.

[0046] Moreover, although are considered as the configuration which forms two closed space which intercepted a closed space mechanically and became independent mutually by latching valves 8 and 15 with the above-mentioned 2nd operation gestalt, and the ejector 5 infixed in a fuel gas circulation supply line and a fuel cell 10 constitute the pressure loss section and the pressure drawdown in the part of fuel leakage influences all the closed space, the effect degree is restricted by said pressure loss section.

[0047] That is, as for the pressure drawdown rate in the fuel gas supply line 6, and the pressure drawdown rate in fuel gas discharge Rhine 11 and the fuel gas circulation line 12, the pressure drawdown rate of the direction which fuel leakage has generated becomes larger. Therefore, without forming latching valves 8 and 15, it is possible to pinpoint the generating part of fuel gas leakage, and the 3rd operation gestalt considered as the starting configuration is shown below.

[0048] Drawing 5 receives the system configuration Fig. of drawing 1 which shows the fuel cell system of the 3rd operation gestalt, and shows the 1st operation gestalt, adds a pressure gage 9 to fuel gas discharge Rhine 11, and detects a pressure to each with this pressure gage 9 and the pressure gage 7 formed in the fuel gas supply line 6. And detection of fuel gas leakage using said manometers 7 and 9 is

performed by the procedure shown in the flow chart of drawing 6.

[0049] In the flow chart of drawing 6, like said step S1 - step S3, on condition that the output current i of a fuel cell 10 is smaller than a threshold i_0 , at step S31 - step S33, processing which holds compulsorily a purge valve 13 and the reduced pressure regulator valve 3 to a closed state is performed. Here, since the ejector 5 infixed in the closed space of a fuel gas circulation supply system and a fuel cell 10 serve as the pressure loss section, it will be divided into two closed space of the fuel gas supply line 6, and the fuel gas discharge Rhine 11 and the fuel gas circulation line 12 in false.

[0050] At step S34, with said output current breaker 30, the output of the output current i is intercepted and a generation of electrical energy (consumption of fuel gas) of a fuel cell 10 is stopped. Two closed space which does not show the fall with a pressure rapid when there is no leakage of fuel gas by the above-mentioned processing is formed in false. In step S35, based on the detection pressure force P_1 of a pressure gage 7, Variation $\Delta P_1 / \Delta t$ (pressure drop rate) is calculated, and Variation $\Delta P_2 / \Delta t$ (pressure drop rate) is calculated at step S36 based on the detection pressure force P_2 of a pressure gage 9.

[0051] step S37 -- step S -- it distinguishes whether variation $\Delta P / \Delta t$ which chose the larger one of the variation ΔP_1 computed by 35 and $\Delta P_2 / \Delta t$ [Δt and]/the Δt (the one where fall velocity is quicker), and was chosen at step S37 in step S38 is larger than a threshold A. And when larger than a threshold A, while variation $\Delta P / \Delta t$ progresses to step S39 and performs the output and leak-detection display output of a leak-detection signal, a fuel gas leakage generating part is made to memorize by memorizing the pressure gages 7 and 9 which progressed to step S40, for example, detected leakage generating.

[0052] Although considered as the configuration which detects the leakage of fuel gas with the above 1st - the 3rd operation gestalt based on the pressure drawdown in the closed space of the fuel gas circulation supply system containing the fuel cell 10 with which supply of fuel gas was intercepted and the generation of electrical energy was stopped Although there is no consumption of the fuel in a fuel cell 10 when the leakage of fuel gas occurs, the flow of fuel gas will occur in a closed space, and order differential pressure will be produced in the pressure loss sections, such as an ejector 5, a fuel cell 10, and the reduced pressure regulator valve 3.

[0053] So, with the 4th operation gestalt shown below, fuel gas leakage is detected based on said order differential pressure. Drawing 7 is what shows the fuel cell system of the 4th operation gestalt. The 1st differential pressure gage 16 which detects the differential pressure of the fuel gas supply line 2 before and behind the reduced pressure regulator valve 3, and the fuel gas supply line 4, The 2nd differential pressure gage 17 which detects the differential pressure of the fuel gas supply line 4 before and behind an ejector 5, and the fuel gas supply line 6, The 3rd differential pressure gage 18 which detects the differential pressure of the fuel gas circulation line 12 before and behind an ejector 5 and the fuel gas supply line 6, and the 4th differential pressure gage 19 which detects the differential pressure of the fuel gas supply line 6 before and behind a fuel cell 10 and fuel gas discharge Rhine 11 are formed.

[0054] The differential pressure output value of each differential pressure gages 16-19 (a pressure condition detection means, differential pressure detection means) is set to ΔP_1 , ΔP_2 , ΔP_3 , and ΔP_4 here. And the pressure-sensitive polarity of each differential pressure gages 16-19 The value of the plus as said differential pressure output values ΔP_1 , ΔP_2 , ΔP_3 , and ΔP_4 when the near pressure shown in drawing 7 with a plus sign is relatively high shall be outputted. And detection of fuel gas leakage using said differential pressure gages 16-19 is performed by the procedure shown in the flow chart of drawing 8.

[0055] First, at step S51, it distinguishes whether the output current i (electric load) is smaller than a threshold i_0 . And when smaller than a threshold i_0 , it progresses to step S52 and a purge valve 13 is compulsorily held to a closed state, and at the following step S53, with said output current breaker 30, the output current i (electric load) intercepts the output of the output current i , and stops a generation of electrical energy (consumption of fuel gas) of a fuel cell 10.

[0056] At step S54, the output values ΔP_1 , ΔP_2 , ΔP_3 , and ΔP_4 of each differential pressure gages 16-19 are read. At step S55, the read output values ΔP_1 , ΔP_2 , ΔP_3 , and ΔP_4

P4 compare and judge the threshold A which determined beforehand whether it would be larger than the minute pressure variation within an electrical signal noise or the design value of a fuel cell system as the absolute value of each output values delta P1, delta P2, delta P3, and delta P4.

[0057] Here, when all the output values delta P1, delta P2, delta P3, and delta P4 are below the thresholds A, it progresses to step S56, and considers that the detection differential pressure of all the differential pressure gages 16-19 is 0, and the judgment without fuel gas leakage is made at the following step S57. When all detection differential pressure is 0, it is shown that the flow of the fuel gas in the fuel gas circulation supply lines 4, 6, 11, and 12 has stopped, and since it agrees with the condition of having stopped in piping without consuming fuel gas, since this stopped the generation of electrical energy of a fuel cell 10, it is judged that fuel gas leakage is not generated.

[0058] If it is judged that there are some which exceed a threshold A in output values delta P1, delta P2, delta P3, and delta P4 at step S55 on the other hand, it will progress to step S58. At step S58, about that the absolute value of whose is below the threshold A among the output values of differential pressure gages 16-19, it is regarded as 0, and only the direction of differential pressure is saved by plus and minus about the thing exceeding a threshold A.

[0059] And at step S59, the generating part of fuel gas leakage is pinpointed based on the comparison with a judgment map as shown in drawing 9, and an actual differential pressure detection pattern. For example, to the detection result of the 1st differential pressure gage 16 being plus, when the detection result of the 2nd differential pressure gage 17 is 0 or minus, it judges with that from which fuel gas has leaked in the fuel gas supply line 4 (Q0 piping).

[0060] Namely, that the detection result of the 1st differential pressure gage 16 is plus While the flow of the fuel gas which goes [in / the pressure of the downstream is lower than the upstream of the reduced pressure regulator valve 3, and / the reduced pressure regulator valve 3] to a fuel cell 10 side will have occurred When the detection result of the 2nd differential pressure gage 17 is 0 or minus With an ejector 5, the flow which there is no flow or goes to the fuel gas supply line 4 side from the fuel gas supply line 6 side will have arisen, and this will show generating of the fuel gas leakage in the fuel gas supply line 4.

[0061] moreover, when both the detection differential pressure of the 3rd differential pressure gage 18 and the 4th differential pressure gage 19 is minus The pressure of the fuel gas supply line 6 will be lower than fuel gas discharge Rhine 11 and the fuel gas circulation line 12. This The flow which flows into the fuel gas supply line 6 side through a fuel cell 10 from fuel gas discharge Rhine 11 occurs. The flow which flows into coincidence through an ejector 5 at the fuel gas supply line 6 side from the fuel gas circulation line 12 will have occurred, and this will show generating of the fuel gas leakage in the fuel gas supply line 6 (Q1 piping).

[0062] on the contrary, when both the detection differential pressure of the 3rd differential pressure gage 18 and the 4th differential pressure gage 19 is pluses The pressure of fuel gas discharge Rhine 11 and the fuel gas circulation line 12 will be lower than the fuel gas supply line 6. This The flow which flows into the fuel gas discharge Rhine 11 side through a fuel cell 10 from the fuel gas supply line 6 occurs. The flow which flows into coincidence through an ejector 5 at the fuel gas circulation line 12 side from the fuel gas supply line 6 will have occurred, and this will show generating of the fuel gas leakage in fuel gas discharge Rhine 11 and the fuel gas circulation line 12 (Q2 piping).

[0063] In addition, the half-tone-dot-meshing display in drawing 9 can show the minimum combination required for a leakage part judging, and can pinpoint a leakage part only in the combination of a half-tone-dot-meshing part. However, judging from all differential pressure outputs is also possible, and when the conditions which are not indicated by drawing 9 are detected, the whole fuel cell system judges that a certain fault is caused, and you may make it output important alarms, such as an emergency shut down, in that case.

[0064] If a leakage generating part is pinpointed at step S59, in step S60, a judgment result is memorized as hysteresis information in preparation for subsequent repair, at the following step S61, leakage generating will be told by the alarm or display, and the actuation for security will be demanded from an operator. If it is the configuration of detecting the generating flow of the fuel gas accompanying

fuel leakage based on differential pressure as mentioned above, high detection sensitivity can be obtained without being influenced by the absolute pressure in piping, and very small fuel gas leakage can be detected by this, and cost can also be made cheap.

[Translation done.]

* NOTICES *

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2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The block diagram of the fuel cell system in the 1st operation gestalt.

[Drawing 2] The flow chart which shows the procedure of the leak detection in the 1st operation gestalt.

[Drawing 3] The block diagram of the fuel cell system in the 2nd operation gestalt.

[Drawing 4] The flow chart which shows the procedure of the leak detection in the 2nd operation gestalt.

[Drawing 5] The block diagram of the fuel cell system in the 3rd operation gestalt.

[Drawing 6] The flow chart which shows the procedure of the leak detection in the 3rd operation gestalt.

[Drawing 7] The block diagram of the fuel cell system in the 4th operation gestalt.

[Drawing 8] The flow chart which shows the procedure of the leak detection in the 4th operation gestalt.

[Drawing 9] Drawing showing the judgment map used for a leakage part judging with the 4th operation gestalt.

[Description of Notations]

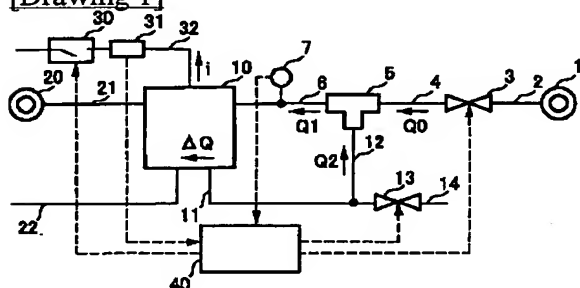
- 1 -- Source of hydrogen gas supply
 - 2 -- Fuel gas supply line
 - 3 -- Reduced pressure regulator valve
 - 4 -- Fuel gas supply line
 - 5 -- Ejector
 - 6 -- Fuel gas supply line
 - 7 9 -- Pressure gage
 - 8 15 -- Latching valve
 - 10 -- Fuel cell
 - 11 -- Fuel gas discharge Rhine
 - 12 -- Fuel gas circulation line
 - 13 -- Purge valve
 - 14 -- Purge line
 - 16-19 -- Differential pressure gage
 - 20 -- Oxidant gas source of supply
 - 21 -- Gas supply Rhine
 - 22 -- Discharge Rhine
 - 30 -- Output current breaker
 - 31 -- Ammeter
 - 32 -- Output wiring
 - 40 -- Signal processor
-

[Translation done.]

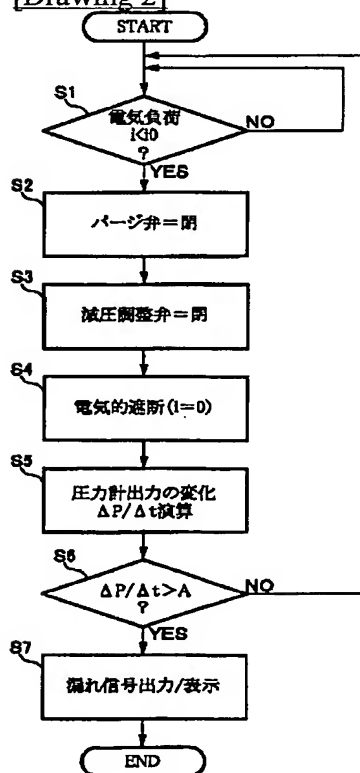
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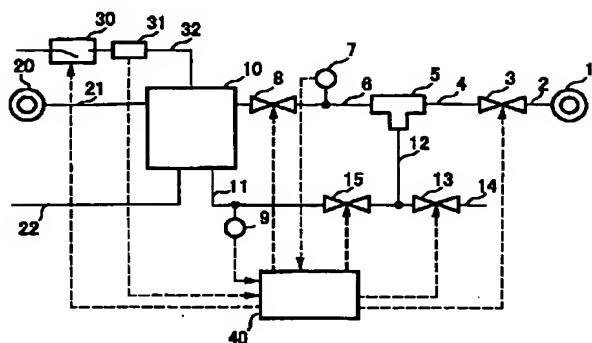
[Drawing 1]



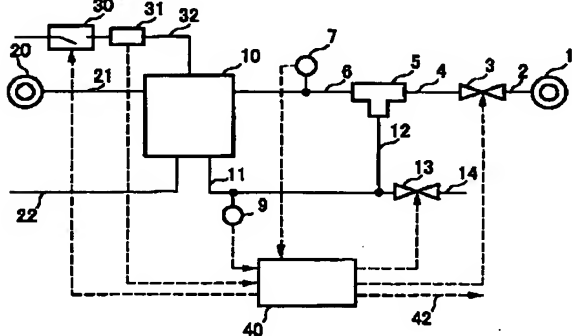
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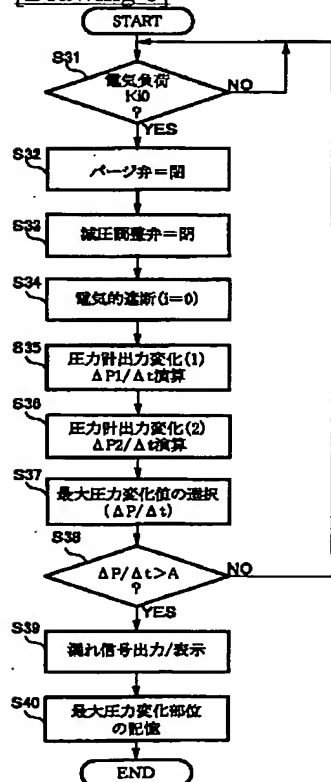
[Drawing 3]



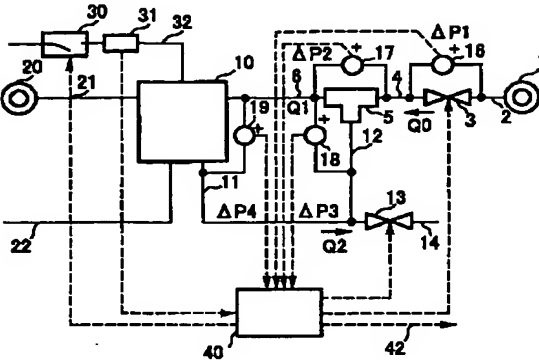
[Drawing 5]



[Drawing 6]



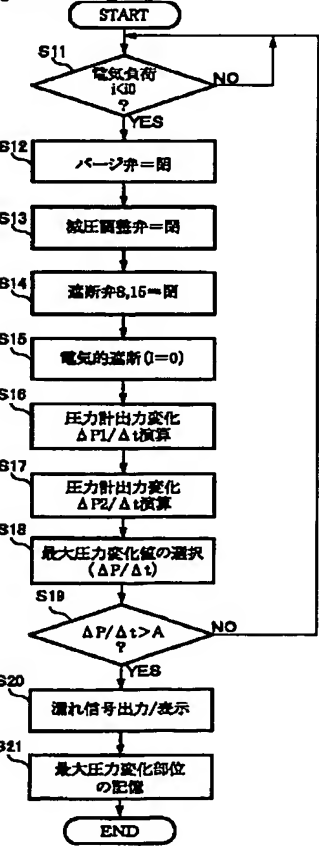
[Drawing 7]



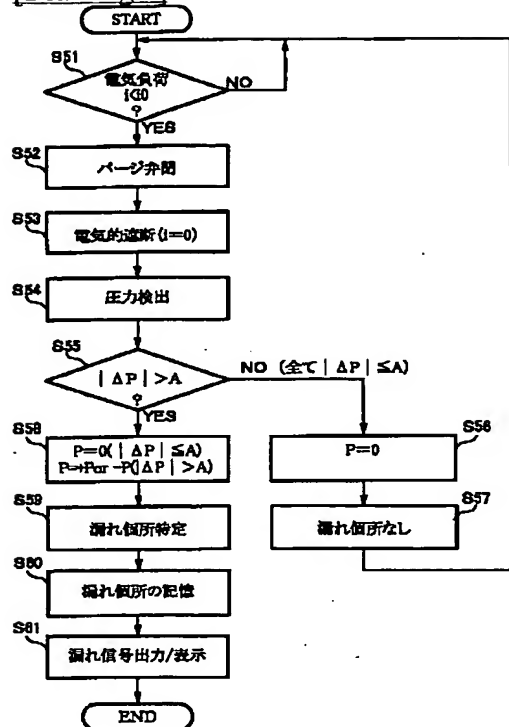
[Drawing 9]

	差圧計出力				漏れ箇所
	$\Delta P1$	$\Delta P2$	$\Delta P3$	$\Delta P4$	
1	0	0	0	0	なし
2	+P	0 or -P	0 or -P	0 or -P	Q0配管上
3	0 or +P	+P	-P	-P	Q1配管上
4	0 or +P	+P	+P	+P	Q2配管上

[Drawing 4]



[Drawing 8]



[Translation done.]

(51) Int. Cl. ⁷ H O I M	登録記号	審査請求 未請求 請求項の数 I I O L	(21) 出願番号	(22) 出願日	(71) 出願人	(72) 発明者	(73) 発明者	(74) 代理人	備考
	8/04	特願2002-113564 (P2002-113564)		平成14年4月16日 (2002. 4. 16)	日産自動車株式会社 神奈川県横浜市神奈川区宝町2番地	酒井 欣信	酒井 欣信	100078330	7-73-1* (参考) Z 5H027
	8/04				日産自動車株式会社 神奈川県横浜市神奈川区宝町2番地	上原 哲也	上原 哲也	100078330	
	8/04				自動車株式会社内			弁理士 智島 富二雄	

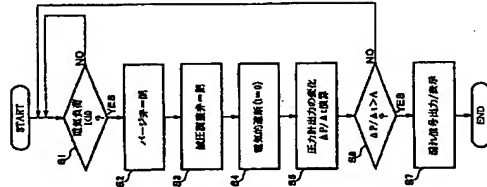
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(54)【発明の名称】燃料電池システムのガス漏れ検知方法及び装置

(57) 【聖約】

【課題】 車両用燃料電池システムにおいて、燃料ガス循環供給系からの燃料ガスの漏れを、運転中に検知できる低価な検知装置を提供する。

【解説要旨】 資源エネルギーの回収時などに、燃料電池の出力電圧が問題よりも小さくなること（S1）、出力電圧低下現象例によって出力電流を1Aを超過して、燃料電池の発電を中止させる一方（S4）、循環系から燃料供給のみに水を排出させるためのバypass、及び燃料供給源から燃料ガスの供給を制御する減圧調整弁を強制的に閉じる（S2、S3）。このときに、燃料ガス循環供給系との閉空間内の圧力を圧力計で検出し、該圧力計の結果を制御部内の圧力を圧力計で検出し、該圧力計の結果に基づいて、基礎以上の逆起の圧力降下を示す場合に、燃料ガス漏れの発生を判定する（S5～S7）。



【特許請求の範囲】

【請求項1】 燃料電池の電気負荷が阻値よりも小さいときに、前記燃料電池の出力電流を遮断し、このときの前記燃料電池を含む燃料ガス循環供給系の閉空間における主電力状態に基づいて、前記閉空間における燃料ガス濃度を検知することを特徴とする燃料電池システムのカス漏れ検知方法。

【請求項1】 前記閉空間への燃料供給源からの燃料ガスの供給が強制的に遮断し、該閉空間における圧力低下を更に基として燃料ガス漏れを検知することを特徴とする請求項1記載の燃料電池システムのガス漏れ検知方法。

【請求項2】 前記閉空間内の圧力損失率の前後差に基いて燃料ガス漏れを検知することを特徴とする請求項1記載の燃料電池システムのガス漏れ検知方法。

【請求項 4】 燃料電池、燃料供給源、燃料ガス循環供給系を含んで構成される燃料電池システムにおいて、前記燃料電池の出力電流を遮断する出力電流遮断手段と、

前記燃料電池を含む燃料ガス循環供給系の閉空間内の圧力状態を検出する圧力状態検出手段と、
前記燃料電池の電気負荷が閾値よりも小さい状態を判別する電気負荷判別手段と、

[illegible]

【請求項5】燃料電池、燃料供給源、燃料ガス循環供給系を含んで構成される燃料電池システムにおいて、前記燃料電池の出力電流を遮断する出力電流遮断手段と、

前記燃料ガス循環供給系への燃料供給源からの燃料ガスの供給を強制的に遮断する供給源遮断手段と、前記燃料電池を含む燃料ガス循環供給系の閉空間内における圧力を検出する圧力検出手段と、

前記燃料電池の電気負荷が閾値よりも小さい状態を判別する電気負荷判別手段と、
該電気負荷判別手段で燃料電池の電気負荷が閾値よりも小さいと判別されたときに、前記出力電力遮断手段によ

[illegible]

料ガス溢れ判断手段と、

を含有し得たことを特徴とする燃料電池システム
のガス漏れ検知装置

【請求項１】前記空腔室を含む燃料ガス循環供給系の閉空間と複数の閉空間とに連通する閉空間が手手段を備え、その共に、前記圧力検出手手段が前記複数の閉空間それぞれに設けられ、前記圧力検出手手段は、前記燃料ガスの漏れを検出するための圧力を検出するように構成し、前記燃料ガスの漏れ判断手段が、前記複数の閉空間毎の圧力低下速度に基づいて、燃料ガスの漏れの有無及び燃料ガス5記載の燃料電池システムのガス漏れ検知装置

【請求項7】前記圧力低下手段が、前記閉空間内の圧力損失部の間における圧力差が閾値所でそれぞれに検出し、前記燃料ガス漏れ判断手段が、それぞれの検出部位における圧力低下速度に基づいて、燃料ガス漏れの有無および燃料ガス漏れの発生箇所を判断することを特徴とする請求項5記載の燃料電池システム。図。

【請求項8】前記燃料ガス漏れ判断手段が、前記それらの検出部位における圧力降下速度のうちの最も大きな圧力降下速度が閾値よりも大きいときに、最も大きな降下速度を示した検出部位での燃料ガス漏れの発生を判断することを特徴とする請求項7記載の燃料電池システム。このガス漏れ検知装置。

【請求項9】燃料電池、燃料供給源、燃料ガス循環供給系を含んで構成される燃料電池システムにおいて、前記燃料電池の出力電流を遮断する出力電流遮断手段と、

前記燃料電池を含む燃料ガス循環供給系の閉空間における少なくとも一つの圧力損失部の前後差圧を検出する差圧検出手段、

前記燃料電池の電気負荷が閾値よりも小さい状態を判別する電気負荷判別手段と、

該電氣負荷判別手段で燃料電池の電氣負荷が閾値よりも小さいと判別されたときに、前記出力電流遮断手段により燃料電池の出力電流を遮断する遮断制御手段と、前記出力電流遮断手段により出力電流の遮断が行われているときに、前記差圧検出手段で検出される差圧に基づいて、前記燃空室からの燃料ガス領域の有無を判断する燃料ガス領域判断手段と、

を舍んで構成されたことを特徴とする燃料電池システム
のガス漏れ検知装置。

【請求項1】前記差圧検出手段が、前記閉空間内に於ける複数の圧力損失部の前後位置をそれぞれ検出し、燃料ガスの燃焼の発生を判断するに、前記前後差圧が閾値より大ききとき、燃料ガスの燃焼の発生を判断するに、関係する燃焼部それぞれでの差圧の方向に基づいて、燃料ガスの燃焼の発生箇所を判断することを特徴とする請求項9記載の燃料電池システム、燃料電池の検知装置、

【請求項11】前記燃料電池システムが、燃料ガス検知手段が、燃料電池の燃焼の発生箇所を判断するに、関係する燃焼部それぞれでの差圧の方向に基づいて、燃料ガスの燃焼の発生箇所を判断することを特徴とする請求項9記載の燃料電池システム、燃料電池の検知装置、

7
される。
【0024】上記燃料ガス供給ライン2、減圧調整弁3（供給源遮断手段）、燃料ガス供給ライン4、エジェクタ5、燃料ガス供給ライン6、燃料ガス排出ライン11及び燃料ガス循環ライン12によって、燃料ガス循環供給系が構成される。前記燃料ガス排出ライン11は、バージ弁13が介装されるバージライン14が接続されている。

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【0025】上記バージ弁13及びバージライン14によってバージ手段が構成される。前記バージ弁13は、燃料ガス排出ライン11に流まった水を燃料ガスと共に排出させるときに開閉制御される。一方、燃料電池10の空気極（図示省略）には、酸化ガス供給源20からの酸化ガス（空気）がガス供給ライン21を介して供給され、燃料電池10にて消費されなかった酸化ガスは、排出ライン22を介して排出される。

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【0026】また、前記燃料電池10の出力電流 i を出力する出力配線32には、出力電流 i を抽出する電流計31、及び前記出力電流 i を遮断する出力電流遮断器33、及び前記出力電流 i を遮断する出力電流遮断手段34（出力電流遮断手段）が介装される。更に、前記燃料ガス供給ライン6内の圧力を検出する圧力計7（圧力検出手段）、圧力検出手段1が設けられている。

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【0027】前記電流計31及び圧力計7の検出力が入力される信号処理装置40は、前記バージ弁13及び出力電流遮断器33の開閉動作を制御すると共に、減圧調整弁3を自動的に遮断させる機能を有している。上記構成において、エジェクタ5で減圧ガス流量 Q_2 を加えた流量 Q_1 （ $-Q_0+Q_2$ ）が燃料電池10の燃料極に導かれる。

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【0028】燃料電池10では、出力電流 i に見合った ΔQ の流量が消費され、残った燃料ガス Q_2 が循環し、燃料ガス供給ライン6に逆流されるようになっている。即ち、燃料電池10の燃料極に供給される燃料ガス流量は、 $\Delta Q=Q_1-Q_2=Q_0$ の流量があり、前記減圧調整弁3は、燃料電池10における消費燃料量（燃料ガス循環供給ラインの圧力低下）に見合った燃料ガスを供給する。

【0029】ここで、車両で要求される電気負荷、即ち、出力電流 i は、非常に大きく変動し得る値であり、例えば車両制動時（非運転時）に、車両駆動エネルギーを電気エネルギーに変換する回生制動装置を備える場合には、電気エネルギーが回生制動によって結集されるために、燃料電池10からの出力電流 i が不要、或いは極めて小さな値になり、このとき減圧調整弁3は燃料ガスの流れを遮断するが供給流量 Q_0 を微小に絞ることになる。

【0030】そして、回生制動が終了すれば出力電流をゼロ（又は微小値）にする条件が解除されるため、車両電気負荷に対応する要求電流 i に見合った燃料ガス消費

に設けた警告灯の点灯などを行う制御信号である。
【0037】上記実施形態による燃料ガス漏れ検知では、運転中に出力電流 i （電気負荷）が閾値 10 よりも小さくなる毎（例えば減速運転時）に、燃料ガス漏れの有無を判断させることができるため、燃料ガス漏れの発生を容易く検知できると共に、比較的低下圧力計7を用いるため、低コストで漏れ検知装置を構成できる。

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ところで、上記実施形態では、減圧調整弁3、燃料ガス供給ライン4、エジェクタ5、燃料ガス供給ライン6、燃料電池10、燃料ガス排出ライン11及び燃料ガス循環ライン12を含んでなる燃料ガス循環供給系の閉空間に対して、1つの圧力計7を設ける構成であるため、閉空間のいずれかでの燃料ガス漏れが発生していることを検知できるものの、漏れ発生箇所を限定することができない。

【0038】そこで、図3に示す第2の実施形態に示すように、燃料ガス循環供給系の閉空間を、更に2つの閉空間に分断遮断する遮断弁8、15（閉空間分断手段）を設けると共に、該遮断弁8、15で遮断される閉空間毎に圧力計7、9を設けるようにして、いずれの圧力検出値が、所定以上の圧力低下速度を示すかによって、燃料ガス漏れの箇所を前記2つの閉空間のいずれかに特定することができる。

【0039】具体的には、燃料ガス供給ライン6の途中に第1遮断弁8を介装し、かつ、燃料ガス排出ライン11の途中に第2遮断弁15を介装する一方、第1遮断弁8とエジェクタ5との間の燃料ガス供給ライン6内の圧力を検出するように圧力計7を設け、第2遮断弁15と燃料電池10との間の燃料ガス排出ライン11内の圧力を検出するように圧力計9を設ける。

【0040】そして、第2の実施形態では、図4のフローチャートに示すようにして漏れ検知を行う。図4のフローチャートにおいて、ステップS11〜ステップS13では、前記ステップS11〜ステップS3と同様に、燃料電池10の出力電流 i が閾値 10 より小さいことを条件に、バージ弁13及び減圧調整弁3を強制的に閉状態に保持する処理を行う。

【0041】更に、次のステップS14で前記遮断弁8、15を閉じること、燃料ガス循環供給系の閉空間を2つに分断遮断する。そして、ステップS15では、前記出力電流遮断器30によって出力電流 i の出力を遮断し、燃料電池10の発電（燃料ガスの消費）を止め、上記処理により、燃料ガスの漏れがない場合には圧力が急激な低下を示すことのない2つの閉空間が形成される。

【0042】ステップS16では、圧力計7の検出圧力 P_1 に基づいて、変化量 $\Delta P_1/\Delta t$ （圧力低下速度）を演算し、ステップS17では、圧力計9の検出圧力 P_2 に基づいて、変化量 $\Delta P_2/\Delta t$ （圧力低下速度）を演算する。ステップS18では、ステップS16、17

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で算出した変化量 $\Delta P_1/\Delta t$ 、 $\Delta P_2/\Delta t$ のうちの大きい方（低下速度が高い方）を選択し、ステップS19では、ステップS18で選択した変化量 $\Delta P/\Delta t$ が閾値 A よりも大きいか否かを判断する。

【0043】そして、変化量 $\Delta P/\Delta t$ が閾値 A よりも大きいときには、ステップS20へ進み、漏れ検知信号21へ進んで、漏れ検知発生を検知した圧力計7、9を記憶することで、燃料ガス漏れ発生部位を記憶させる。漏れ発生箇所を記憶することで、例えば漏れが一次的に発生し、その後漏れ部が癒えてきて漏れが出力されなくなっても、漏れの履歴及び漏れ発生箇所を後から知ることができる。

【0044】尚、漏れ発生箇所の記憶は、前記信号処理装置40内のメモリ等を用いても良い。個別に設けた記憶装置に記憶させても良い。本実施形態では、閉空間を遮断弁8、15によって2つに分断遮断したから、例えば、圧力計7の検出圧力の低下速度が他方よりも大きく、かつ、閾値 A を超える値を示した場合に、遮断弁15から燃料ガス循環ライン12、エジェクタ5を経由して遮断弁8に至る閉空間のいずれかで燃料ガス漏れが発生していることになり、逆に、閾値 A を超える値の低下速度が他方よりも大きく、かつ、閾値 A を超える値を示した場合に、遮断弁8から燃料電池10、燃料ガス排出ライン11を経由して遮断弁15に至る閉空間のいずれかで燃料ガス漏れが発生していることになる。

【0045】尚、上記実施形態では、閉空間を2つに分断遮断してそれぞれに圧力計を設けることで、2つの閉空間のいずれか一方に漏れ発生箇所を特定できる構成としたが、分割遮断する閉空間の数を3つ以上とし、それぞれに圧力計を備えるようにすれば、より細かく燃料ガス漏れ箇所を特定することができる。但し、実用上は燃料ガス供給システムの規模や配置構造等により必要数を決定すれば良い。

【0046】また、上記第2実施形態では、遮断弁8、15によって閉空間を機械的に遮断し、相互に独立した2つの閉空間を形成する構成としたが、燃料ガス循環供給ラインに介装されるエジェクタ5、燃料電池10は圧力損失部を構成し、燃料電池の箇所での圧力低下が閉空間の全てに影響するものの、その影響度合いは、前記圧力損失部により制限される。

【0047】即ち、燃料ガス供給ライン6での圧力低下速度と、燃料ガス排出ライン11及び燃料ガス循環ライン12での圧力低下速度とは、燃料漏れが発生している方の圧力低下速度がより大きくなる。従って、遮断弁8、15を設けることなく、燃料ガス漏れの発生箇所を特定することが可能であり、係る構成とした第3の実施形態を以下に示す。

【0048】図5は第3の実施形態の燃料電池システムを示すものであり、第1の実施形態を示す図1のシステ

ム横破面に対して、燃料ガス排出ライン11に圧力計9を追加して、該圧力計9と燃料ガス供給ライン6に設けられる圧力計7とによって、それぞれに圧力を検出する。そして、前記圧力計7、9を用いた燃料ガス漏れの検知は、図6のフローチャートに示す手順で行われる。

【0049】図6のフローチャートにおいて、ステップS31～ステップS33では、前記ステップS1～ステップS3と同様に、燃料電池10の出力電流1が閾値1よりも小さいことを条件に、パージ弁13及び減圧調整弁3を逐次的に閉状態に保持する処理を行う。ここで、燃料ガス循環供給系の閉空間に介装されるエジェクタ5、燃料電池10が圧力損失部となるため、仮想的に、燃料ガス供給ライン6と、燃料ガス排出ライン11及び燃料ガス循環ライン12との2つの閉空間に分けられることになる。

【0050】ステップS34では、前記出力電流遮断器30によって出力電流1の出力を遮断し、燃料電池10の発電（燃料ガスの消費）を止める。上記処理により、燃料ガスの漏れがない場合には圧力が急激な低下を示すことのない2つの閉空間が仮想的に形成される。ステップS35では、圧力計7の検出圧力P1に基づいて、変位 $\Delta P1/\Delta t$ （圧力低下速度）を演算し、ステップS36では、圧力計9の検出圧力P2に基づいて、変位 $\Delta P2/\Delta t$ （圧力低下速度）を演算する。

【0051】ステップS37では、ステップS35、36で算出した変位 $\Delta P1/\Delta t$ 、 $\Delta P2/\Delta t$ のうちの大きい方（低下速度が速い方）を選択し、ステップS38では、ステップS37で選択した変位 $\Delta P/\Delta t$ が閾値Aより大きいか否かを判断する。そして、変位 $\Delta P/\Delta t$ が閾値Aより大ききときは、ステップS39へ進み、漏れ検知信号の出力がなされる。例えば、漏れ発生を検知した圧力計7、9を記憶することで、燃料ガス漏れ発生部位を記憶させる。

【0052】上記第1～第3実施形態では、燃料ガスの供給が遮断され、かつ、発電が止められる燃料電池10を含む燃料ガス循環供給系の閉空間における圧力低下に基づいて、燃料ガスの漏れを検知する構成としたが、燃料ガスの漏れが発生すると、燃料電池10での燃料の消費がないに等しいから、閉空間内に燃料ガスの流れが発生し、エジェクタ5、燃料電池10、減圧調整弁3などの圧力損失部に前後差圧を生じることになる。

【0053】そこで、以下に示す第4の実施形態では、前記前後差圧に基づいて燃料ガス漏れの検知を行う。図7は第4の実施形態の燃料電池システムを示すものであり、減圧調整弁3前後の燃料ガス供給ライン2と燃料ガス供給ライン4との差圧を検出する第1差圧計16、エジェクタ5前後の燃料ガス供給ライン4と燃料ガス供給ライン6との差圧を検出する第2差圧計17、エジェクタ5前後の燃料ガス循環ライン12と燃料ガス供給ライ

燃料ガスが漏れているものと判定する。

【0060】即ち、第1差圧計16の検出結果がプラスであるということは、減圧調整弁3の上流側よりも下流側の圧力が低く、減圧調整弁3において燃料電池10側に向かう燃料ガスの流れが発生していることになる。一方、第2差圧計17の検出結果が0又はマイナスであるときは、エジェクタ5では流れがないか、燃料ガス供給ライン6側から燃料ガス供給ライン4側に向かう流れが生じていることになり、これは、燃料ガス供給ライン4における燃料ガス漏れの発生を示すことになる。

【0061】また、第3差圧計18及び第4差圧計19の検出差圧が共にマイナスであった場合には、燃料ガス排出ライン11、燃料ガス循環ライン12よりも燃料ガス供給ライン6の圧力が低いことになり、これは、燃料ガス排出ライン11から燃料電池10を介して燃料ガス供給ライン6側に流れ込む流れが発生し、同時に、燃料ガス循環ライン12からエジェクタ5を介して燃料ガス供給ライン6側に流れ込む流れが発生していることになり、これは、燃料ガス供給ライン6（Q1配管）における燃料ガス漏れの発生を示すことになる。

【0062】逆に、第3差圧計18及び第4差圧計19の検出差圧が共にプラスであった場合には、燃料ガス供給ライン6よりも燃料ガス排出ライン11、燃料ガス循環ライン12の圧力が低いことになり、これは、燃料ガス供給ライン6から燃料電池10を介して燃料ガス排出ライン11側に流れ込む流れが発生し、同時に、燃料ガス供給ライン6からエジェクタ5を介して燃料ガス循環ライン12側に流れ込む流れが発生していることになり、これは、燃料ガス排出ライン11、燃料ガス循環ライン12（Q2配管）における燃料ガス漏れの発生を示すことになる。

【0063】尚、図9中の網掛け表示は、漏れ箇所判定に必要な最小の組み合わせを示し、網掛け部分の組み合わせのみで漏れ箇所を特定することができる。但し、全ての差圧出力から判定することも可能であり、その際には、図9に記載されない条件が検出された場合、燃料電池システム全体が何らかの不具合を起していることと判断し、緊急停止など重要な警報を出力するようにしても良い。

【0064】ステップS59で漏れ発生箇所の特定を行うと、ステップS60では、判定結果をその後の修理作業等に備えて履歴情報として記憶し、次のステップS61では、運転者に対しては、漏れ発生を警報または表示にて知らせ、安全確保のための操作を促す。上記のように差圧に基づいて、燃料漏れに伴う燃料ガスの流れの発生を検出する構成であれば、配管内の絶対圧に左右され

ずに高い検出感度を得ることができ、これによって減少燃料ガス漏れの検知を行え、またコストも安くできる。

【図面の簡単な説明】

【図1】第1の実施形態における燃料電池システムのブロック図。

【図2】第1の実施形態における漏れ検知の手順を示すフローチャート。

【図3】第2の実施形態における燃料電池システムのブロック図。

【図4】第2の実施形態における漏れ検知の手順を示すフローチャート。

【図5】第3の実施形態における燃料電池システムのブロック図。

【図6】第3の実施形態における漏れ検知の手順を示すフローチャート。

【図7】第4の実施形態における燃料電池システムのブロック図。

【図8】第4の実施形態における漏れ検知の手順を示すフローチャート。

【図9】第4の実施形態で漏れ箇所判定に用いる判定マップを示す図。

【符号の説明】

1…水素ガス供給源

2…燃料ガス供給ライン

3…減圧調整弁

4…燃料ガス供給ライン

5…エジェクタ

6…燃料ガス供給ライン

7、9…圧力計

8、15…遮断弁

10…燃料電池

11…燃料ガス排出ライン

12…燃料ガス循環ライン

13…パージ弁

14…バージライン

16…差圧計

20…燃料ガス供給源

21…燃料ガス供給ライン

22…排出ライン

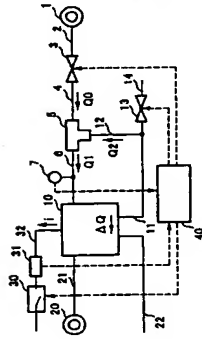
30…出力電流遮断器

31…電流計

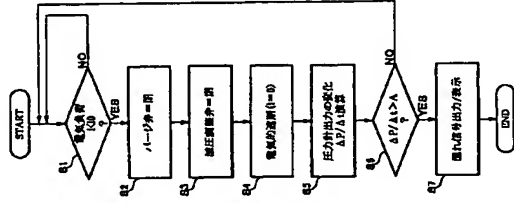
32…出力配線

40…信号処理装置

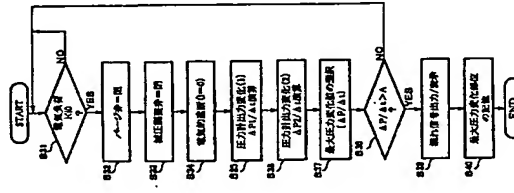
【図1】



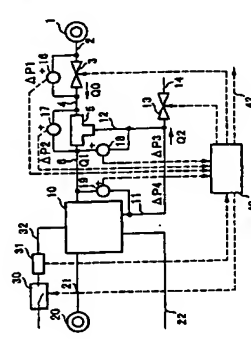
【図2】



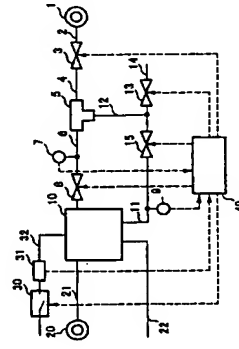
【図6】



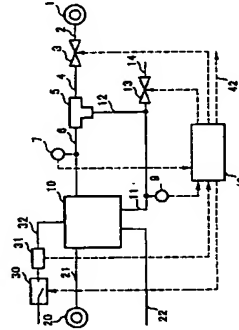
【図7】



【図3】



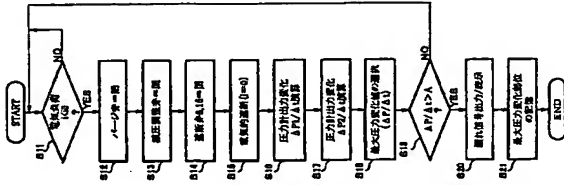
【図5】



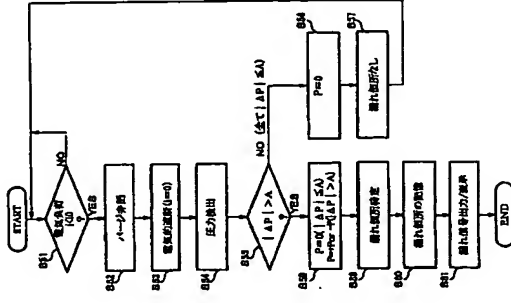
【図9】

	圧力計出力				出力場所
	$\Delta P1$	$\Delta P2$	$\Delta P3$	$\Delta P4$	
1	0	0	0	0	2L
2	0 or +P	0 or -P	0 or +P	0 or -P	Q1配管上
3	0 or +P	+P	+P	+P	Q1配管上
4	0 or +P	+P	+P	+P	Q2配管上

【図4】



【図8】



フロントページの続き

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